This application is a division of my co-
pending application "Treatment of ma-
terial in a vacuum and apparatus", filed
March 4, 1920, Ser. No. 363,351, case G.

The present invention relates to an appa-
ratus and method for the drying of paper
and other material, in a vacuum chamber,
and then immediately, while still in the
vacuum chamber, coating, or coloring, or
sizing or impregnating the paper or other
material, and then immediately, drying the
coated, colored, sized or impregnated paper
or other material while still in the vacuum
chamber.

My improved method consists in passing
the material which is to be dried into a
vacuum chamber through a liquid sealing
medium which has no affinity for the mate-
rial, subjecting it to heat to drive off its con-
tained moisture, immediately coating or
coloring, or sizing or impregnating the ma-
terial while in the vacuum chamber, then
subjecting the coated or colored, or sized or
impregnated material to heat to drive off its
contained moisture or other liquid, and then
passing the material out of the chamber
through a seal.

This method may be practiced by the use
of various forms of apparatus, some of
which are herein disclosed. In any form,
however, it is essential that the apparatus
be provided with a closed chamber in which a
partial vacuum may be maintained. In or-
der that the material to be dried, treated,
and again dried may be continuously passed
through the vacuum chamber, the latter is
provided with openings closed to the ad-
mission of air by a liquid sealing medium
which has no affinity for the material. The
liquid seal effectively closes the entrance and
exit passages against the admission of air
to the chamber, but permits the passage of
the material into and out of the chamber.

Any other sealing means may be used.

My invention further relates to with-
drawing from the sheet material substantially
all, or a large portion, of its occluded air
and filling the interstices normally filled by
the occluded air with a coating or impreg-
nating compound, and then drying said
coated or impregnated sheet material in the
vacuum chamber before subjecting the said
sheet material to atmospheric conditions.

My invention further relates to obtaining
a better and more uniform product than any
now known on the market. My invention
further relates to the method of coating or
impregnating sheet material which insures
that there will be no blemishes, uneven sur-
faces, blisters or minute raised portions due
to the air which may be held or occluded
within the sheet material, which, in the pres-
ent practice of coating as for example with
a waterproof compound, leads to rejections
or discards due to these imperfections with
the consequent waste of material and labor.

My invention further relates to the treat-
ment of paper, either from the wet end of a
paper machine or from a roll or reel of wet
or damp paper, feeding the web of wet or
damp paper into a vacuum chamber with-
out breaking the vacuum, drying said web
in the vacuum chamber and removing sub-
stantially all of its occluded air, and im-
mediately coating or impregnating or color-
ing or sizing said dry web with a coating or
impregnating or coloring or sizing com-
ound, and then again drying the web, the
second time with its coating or impregnat-
ing or coloring or sized compound, within the
vacuum chamber and all these steps being
continuous and prior to subjecting the
coated or impregnated compound to the
action of the atmosphere.

My invention further relates to manufac-
turing paper wherein the fibers are not
weakened and the size in the paper is not
injured or damaged due to drying at high
temperatures.

My invention further relates to manufac-
turing colored paper and drying it without
substantially impairing the coloring matter
and mordants used in the paper. Among
other advantages this insures that the paper
will have bright colors, which will be sub-
stantially uniform in different runs of paper,
permitting matching of colored paper with-
out any appreciable difference in tone or
color.

My invention further relates to rapidly

and expeditiously coating or impregnating sheet material in a continuous web or sheet. My invention further relates to sizing paper in a vacuum chamber and drying the sized paper in said vacuum chamber at such low temperatures as not to injure the fibers of the paper or the size. My invention further relates to withdrawing the occluded air from the paper and immediately drying and then filling the interstices normally filled with the occluded air with the size, and then drying the thoroughly sized paper in the vacuum chamber before it is subjected to atmospheric conditions. My invention further relates to carrying out this method continuously with a continuous web of paper which passes into and out of the vacuum chamber without breaking the vacuum.

More particularly my present invention relates to passing material into a vacuum chamber, without breaking the vacuum, drying it in the vacuum chamber while under little or no substantial tension, so that the constituent elements, as for example the fibers of paper, will not be substantially changed from the position assumed by them on the wire of the paper making machine; then while still in the vacuum chamber, coating, coloring, sizing or impregnating the material; then drying the coated, sized, colored or impregnated material while still in the vacuum chamber, and preferably while under not sufficient tension to substantially rearrange its constituent elements; and then continuously passing the dry coated, impregnated, colored or sized material out of the vacuum chamber without breaking the vacuum.

My invention further relates to certain steps, and combinations of steps, also to certain elements and combinations of elements, whereby the method or processes herein described may be carried out, as well as to certain details of construction, all of which will be more fully hereinafter described in the specification and pointed out in the claims. In these drawings the same reference numerals refer to similar parts in the several figures.

Fig. 1 is a vertical diagrammatic section of one form of apparatus which may be used to carry out my improved method;

Fig. 2 is a vertical diagrammatic section of a modification in which the material is heated by one or more electric heaters.

In describing my invention I will describe it as applied to material in the form of paper though it is to be distinctly understood that textile fabrics may also be treated by my process and that my broader claims cover all forms of materials.

In the ordinary drying of a web of paper, such high heat is used as to injuriously effect the fibers of the paper; and in case the paper is colored it will materially effect the coloring matter and mordants used. Drying paper in the high temperatures used in ordinary practice often effects the size so that the resulting paper varies in quality, is not uniform and is not a perfect product.

In coating or impregnating fabrics it is found in practice that the coated fabric will frequently have blemishes due to large or small blisters and blow holes, these often being about the size of a pin-head or a pin-point. This is caused by the air which is held or occluded being collected, more or less, in small pockets under the coating or impregnating material, or in some cases causing minute blow holes. In waterproof fabrics this results in large quantities of the material being rejected with the consequent loss to the manufacturer.

By my invention I assure that substantially all the occluded air is withdrawn from the sheet material which will permit the coating or impregnating material, whatever it may be, to thoroughly fill these minute interstices or pockets normally occupied by occluded air, forming thereby a better and more uniform product and one devoid of blisters, blow holes or such blemishes. By my invention I immediately dry such coated or impregnated sheet material while still in the vacuum chamber so that when the sheet material emerges from the vacuum chamber the coating or impregnating material is dry and set without any danger of atmospheric pressure or atmospheric conditions spoiling or marring the finished product.

As previously stated I will describe my invention with relation to coating or impregnating paper, though it is understood that textile fabrics may be treated in the same manner.

In the ordinary commercial paper making machine the fibers of the paper stock or furnish are formed on the wire of the machine. There they are interlaced and locked, more or less, firmly together. Taking the wet web from the wire of the paper machine and running it over a series of heated drying drums or cylinders tends to pull the fibers in the direction of travel of the heated rollers, cylinders or driers as they are technically known. This pull on the wet web, the more the fibers tend to straighten out in the direction of travel of the heated cylinder or drier which is drying the web and moving at high speed. Each succeeding drier tends to augment this pulling of the fibers of the paper.

This not only results in the web shrinking crosswise but materially effects the strength of the resulting paper. By drying the web so that there is little or no tension upon it permits the fibers “to dry at random or at will”. That is, substantially as they were interlaced together on the wire of the paper machine.
This results in the sheet being as strong lengthwise of the sheet as it is crosswise of the sheet. This is not true where considerable tension has been placed on the wet web by passing over large drying drums or cylinders. It is, therefore, obvious that a new result is accomplished.

A coated, colored, sized or impregnated paper of a given strength is obtained with relatively poor stock or furnish. To obtain a coated, colored, sized or impregnated paper of the same strength made by a method in which the fibers of the paper were not permitted to dry at random, or substantially as formed on the wire of the paper machine, would require much better and more expensive stock or furnish.

By my invention the material is fed through the vacuum chamber under just sufficient pull or tension to insure its passage and without substantially causing the constituent elements of the material to rearrange themselves from their original position.

Various means may be used to feed the material into and out of the vacuum chamber without breaking the vacuum and still come within the terms of my invention as previously explained.

For example the web of paper 1 is fed directly from the wet end of a paper making machine, or in some cases it may be fed from a roll or reel 2 of wet or damp paper. The web is fed into the vacuum chamber A by passing over the guide roller 4, into the liquid seal 5, under the submerging roller 6, and thence in contact with the guide roller 7.

This liquid seal 5 may be of any suitable material which has no affinity for the sheet material treated and has no deleterious effect upon it. Preferably I use mercury as the sealing medium 5, but it is to be distinctly understood that any amalgam, alloy, or any other suitable liquid sealing medium may be employed which has the characteristics above specified.

The web 1 is immediately upon its entry into the vacuum chamber A dried preparatory to coating or coloring or sizing or impregnating it; but it is dried in a manner which does not weaken it or cause its fibers to substantially rearrange themselves from the position assumed by them on the wire of the paper making machine.

I have shown the web of paper passing through the vacuum chamber A in folds or loops, passing under the guide rollers 8; 8 and over the guide rolls 9, 9. Preferably I heat the web, or other material, as it passes through the vacuum chamber A, but in a manner which will not cause the fibers to be substantially weakened or pulled out in the direction of travel of the web.

I provide one or more fixed heaters 10, 10 preferably located in the folds or loops but not touching the web as it passes adjacent to them. These heaters 10, 10 may be heated by steam or hot water or otherwise.

By the time the web 1 has reached the guide roll 11 it is thoroughly dry and the web will be substantially as strong lengthwise of the web as it is crosswise of the web.

The web 1 is then immediately passed through the coating, impregnating, coloring or sizing bath 12 in the chamber 13, passing under the submerging roller 14. It is then passed through the squeeze rolls 15, 15 to the guide roll 16.

The web is again dried before passing out of the vacuum chamber. Different drying means may be used to dry the coated or colored, or sized or impregnated web than the means used to dry the wet web before it passed through the bath 12. Preferably, however, I use duplicate drying means which will insure that little or no tension be placed on the web, the tension not being sufficient to substantially cause the fibers to rearrange themselves from the position assumed by them on the wire of the paper making machine.

I have shown in Fig. 1 the second drying means as a duplicate of the first. That is the coated, impregnated, colored or sized web 1 passes over the guide roll 16 it is led in folds or loops through the right hand portion of the vacuum chamber under the guide rolls 17, 17 and over the guide rolls 18, 18. One or more of these folds or loops are heated by the steam radiators 10, 10. Only sufficient pull or tension is placed on the web to feed it through the vacuum chamber A.

When the web has reached the guide roll 19 it is completely dry and the coating, coloring, sizing or impregnating material is dry and set. It is then passed out of the vacuum chamber through the exit seal 5 under the submerging roller 20, over the guide roll 21. It may then be cut, stacked or rolled into a roll of finished material 22.

In Fig. 2 I have shown a modification of my invention in which I use electric heaters 23, 23 instead of the steam radiators 10, 10 to heat the material as it passes through the vacuum chamber before, and also preferably after, passing through the bath 12. This bath may be of any suitable material to coat or impregnate or color sheet material whether it be paper or textile fabric. Simply by way of example, this coating or impregnating bath 12 may be size, tar, wax, or in fact any coating or waterproofing, or impregnating or coloring compound.

The vacuum chamber A is provided with pipes 24, 24 leading to any suitable form of vacuum apparatus. I also preferably provide the vacuum chamber with windows 25, 25 so that the operator can at all times
see into the interior of the vacuum chamber. The chamber 13 in which the bath 12 is located can be drained by the pipe 26 and cock 27. Additional liquid can be supplied to the bath 12 by the pipe 28 controlled by the cock 29. In some cases the coating, coloring, impregnating or sizing bath 12 may be heated in any suitable manner, as for example, by the steam pipes 30, 30.

The thermal efficiency of my vacuum method is very much greater than that of the atmospheric cylinder drying heretofore in universal use for drying paper. Theoretically, it requires about 5287 pounds of steam to dry one ton of paper at atmospheric pressure, but to compensate for convection and conduction losses, and those due to leaks in the piping system, and other inefficiencies, it has been shown in practice that about 10,600 pounds are required.

In my method, using a vacuum of about 28", the convection, conduction and piping losses are exceedingly small and the total steam required to dry a ton of paper by my method is approximately 5200 pounds.

It is an established fact that paper dried at low temperatures is much stronger than when it is dried at the high temperatures used in paper machine atmospheric drying. Paper dried in a vacuum of 28", or at a temperature of about 100° F., and as in my method, is very much stronger than paper dried at atmospheric pressure, when the steam in the driers is at 228° F. When paper is dried by my method, therefore, a cheaper furnish or stock can be used and still produce a coated or impregnated or colored or sized paper equal in strength to atmospheric dried paper, in which a higher grade furnish or stock is used. In making newsprint paper, I am able to dispense with a considerable portion of the more expensive sulphite pulp, as this can be replaced with the cheaper ground wood pulp. By my method I also reduce the number of breaks in the web as it passes over the cylinder.

Furthermore, in my method there is a great saving of heat (or steam) because the process is carried on in a vacuum chamber which acts on the principle of a thermos bottle, and the steam and vapors driven out of the wet paper are caught in the closed vacuum chamber, and conducted away to the condenser. The operating room is free from steam, humidity and heat, and fans, and exhausters are dispensed with. In the use of my method the apparatus is at all times operating under definite humidity, the control of the drying can be closely standardized, and the moisture content in the paper carefully regulated.

Having pointed out the many advantages of my method and apparatus over those heretofore used, it will be apparent that the use of my invention results in great economy in the initial cost of apparatus and in large savings in cost of operation, maintenance and repairs.

Having thus described this invention in connection with illustrative embodiments thereof, to the details of which I do not desire to be limited, what is claimed as new and what is desired to secure by Letters Patent is set forth in the appended claims.

What I claim is:

1. The method of treating porous material in a web consisting in feeding it into and out of a vacuum chamber without breaking the vacuum, drying the material in the vacuum chamber while under little or no tension so as to permit the constituent elements of the porous material to dry while under little or no tension, coating or impregnating the dry porous material, and then drying the coated or impregnated porous material in the vacuum chamber.

2. The method of treating sheet material consisting in feeding it into and out of a vacuum chamber without breaking the vacuum, drying the sheet material in the vacuum chamber in a manner which will permit the constituent elements of the sheet material to dry while under little or no tension, coating or impregnating the dry sheet material, and then drying the coated or impregnated sheet material in the vacuum chamber in a manner which will permit the constituent elements of the coated or impregnated sheet material to dry substantially in their original relative positions.

3. The method of treating a web of sheet material consisting in feeding it into a vacuum chamber through a liquid seal that has no affinity for, or deleterious effect upon, said web of sheet material, drying said web in the vacuum chamber by permitting its constituent elements to shrink or dry with little or no tension upon them, coating or impregnating said web in the vacuum chamber, drying said coated or impregnated web while still in the vacuum chamber, and then passing said dry and coated or impregnated web out of the vacuum chamber through a liquid seal that has no affinity for or deleterious effect upon said coated or impregnated web.

4. The method of treating a wet web of paper consisting in continuously feeding the wet web into and out of a vacuum chamber without breaking the vacuum, drying the web in the vacuum chamber under little or no tension, the tension not being sufficient to materially rearrange the fibers of the paper from their original matted or interlaced position on the wire of the paper machine thereby obtaining a web or sheet of paper substantially as strong lengthwise of the sheet as it was crosswise of the sheet, then continuously while still in the vacuum...
chamber coating, or sizing, or coloring or impregnating the web of paper, and then while still in the vacuum chamber, drying said coated, sized, colored or impregnated web of paper before it is passed into the atmosphere.

5. The method of treating a wet web of paper consisting in continuously feeding the wet web into and out of a vacuum chamber without breaking the vacuum, drying the web in the vacuum chamber under little or no tension, the tension not being sufficient to materially rearrange the fibers of the paper from their original matted or interlaced position on the wire of the paper machine, thereby obtaining a web or sheet of paper substantially as strong lengthwise of the sheet as it is crosswise of the sheet, then continuously while still in the vacuum chamber coating, or sizing or coloring or impregnating the web of paper, and then while still in the vacuum chamber again drying said web while under little or no tension, the tension not being sufficient to substantially rearrange the fibers of the paper from their original position on the wire of the paper machine, and then continuously passing the dry coated or impregnated or colored, or sized paper out of the vacuum chamber without breaking the vacuum.

6. The method of treating a web of paper consisting in feeding the wet web into a vacuum chamber through a liquid seal which has no affinity for or deleterious effect upon said web, continuously drying the web in the vacuum chamber by permitting its fibers to dry while under little or no tension to form a web as strong lengthwise as crosswise of the sheet, continuously sizing the web in the vacuum chamber, continuously drying the sized web in the vacuum chamber by passing the sized web of paper in folds or loops through the vacuum chamber, and continuously withdrawing the dry and sized web from the vacuum chamber through a liquid seal that has not affinity for or deleterious effect upon said web.

7. An apparatus for treating porous material including a vacuum chamber, means to permit the porous material to pass into and out of the said chamber without breaking the vacuum, drying means mounted in the vacuum chamber adapted to permit the porous material to be dried without substantially rearranging the constituent elements of the porous material from their original position, coating, sizing, coloring or impregnating means mounted in the vacuum chamber, and additional drying means mounted in the vacuum chamber to dry the coated, impregnated, colored or sized porous material prior to its passage into the atmosphere.

8. An apparatus for treating porous material including a vacuum chamber, means to permit the porous material to pass into and out of the said chamber without breaking the vacuum, drying means mounted in the vacuum chamber adapted to permit the porous material to be dried in folds or loops without substantially rearranging the constituent elements of the porous material from their original position, coating, sizing, coloring or impregnating means mounted in the vacuum chamber, and additional drying means mounted in the vacuum chamber to dry the coated, impregnated, colored or sized porous material prior to its passage into the atmosphere, and without substantially rearranging its constituent elements.

9. An apparatus for treating paper including a vacuum chamber, liquid seals closing the entrance and exit passages to said chamber, said seals having no affinity for or deleterious effect upon the paper treated, drying means mounted in the vacuum chamber which permit the constituent elements of the paper to dry at will or at random, coating or sizing or coloring or impregnating means mounted in the vacuum chamber, and additional drying means mounted in the vacuum chamber adapted to dry the coated, impregnated, colored or sized paper without substantially rearranging its constituent elements or fibers.

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